TECHNICAL NOTICE

LTN 12034

SUBJECT: End of Life Indication for Memory Back-up Batteries

The two outstanding characteristics of the TADIRAN ™ Lithium Thionyl Chloride batteries are the stable cell voltage during the operating time and the high capacity retention (long shelf life). Many years of production and testing showed that the cell voltage determined by the chemistry is stable during the battery life and only a slight voltage drop is caused due to the temperature changes rather than to the decreasing of capacity. The overall drift of the cell voltage through the full operating temperature range may be about 200-300 mV.

However, the practice and the experience accumulated during the years, showed that at the point of 3-5% residual capacity, the change in the chemistry causes a lowering of the cell voltage to the 3.2-3.3 V level. The following chart emphasizes this part of the time where cell voltage is dropping during operating time (Figure 1).

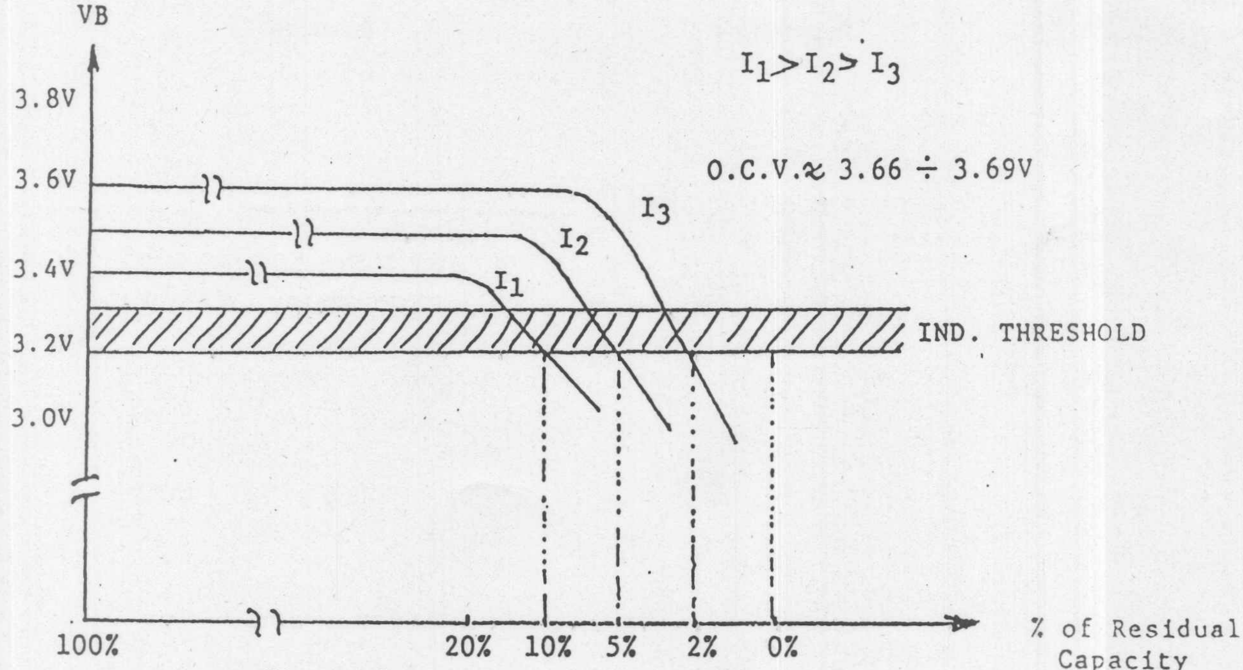

Figure 1.

For memory back-up applications, the end of operating time (95%-98% discharged cell) can be detected at a point where the cell voltage drops below the 3.00V level. The electronic circuit should compare the cell voltage to 3.20V reference voltage source. (Temperature compensation is also recommended.)

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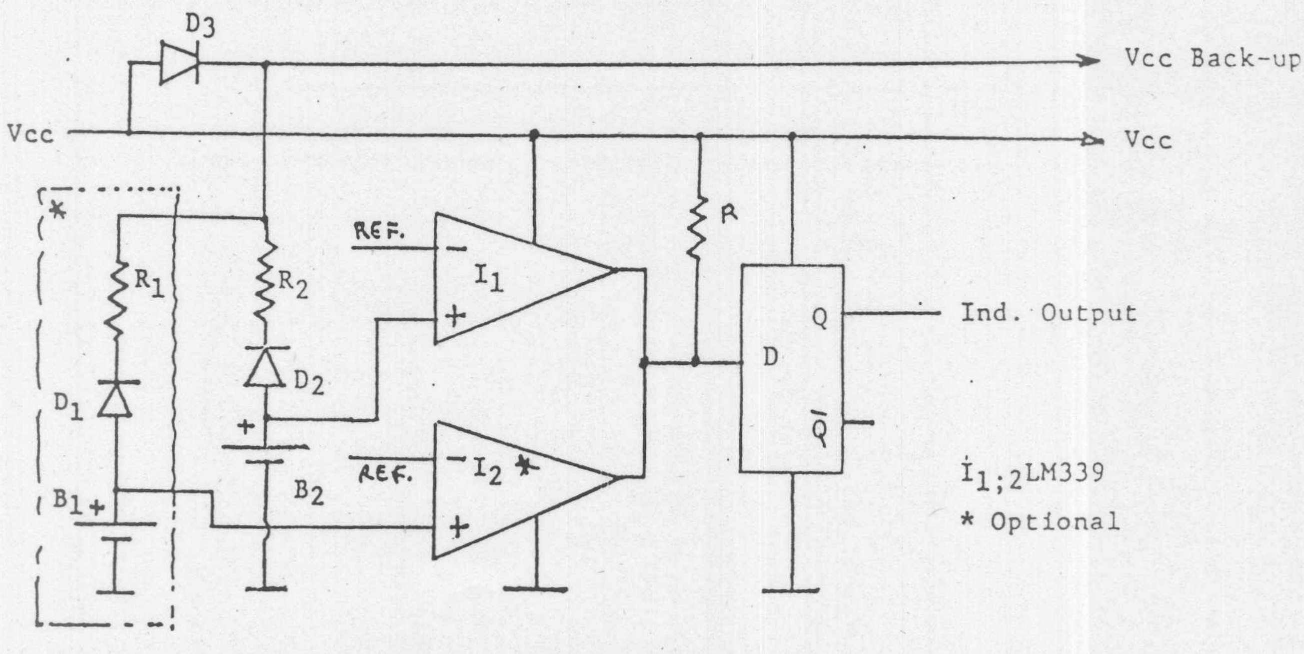
In order to save additional battery energy and to extend its operating lifetime, the low voltage detector circuit should not operate during standby mode, but only when the equipment is fed from main power.

Incorporating a precise voltage comparator (like LM 339), the actual threshold voltage may be adjusted to such a level that after the indication was turned on, the available residual capacity will be about 3-5%.

For long life memory back-up applications (@ 5 years or more), the low voltage indication warning signal will turn on about 1-2 months before the back-up cell voltage drops below the 2.5 level. (Calculation based on 0.4V drop on the serial silicon diode.)

When using the battery for high reliable applications like central switchboards, military communication systems, cash registers, etc., or for applications where the battery is submitted to operate in wide temperature range, the continuity of back-up operation may be assured by using a redundancy back-up battery.

The following schematics is showing the low voltage detector circuit. The cell voltage is tested by the comparator and the indicator turns on if one of the cell voltages drops momentarily or continually below 3.3V.



The resistors R_1, R_2 may be selected to assure priority selection between the two cells. The typical voltage drop on the larger resistor should not exceed 100 mV.

The experience gained by collecting information from the field and continuous laboratory testing by TADIRAN proved the above detailed approach is reliable, and may be utilized in applications where low battery conditions should be indicated.

TADIRAN™ LITHIUM INORGANIC BATTERIES

TECHNICAL NOTICE

LTN 12035

Subject: Designing Low Cost Non-Volatile Memories with High Energy Battery Back-up Source

The most recent trend in the CMOS Industry is to produce larger memory chips with shorter access time, and lower standby current. The reasons for those demands are obvious, and most of the manufacturers of CMOS RAMS concentrate their effort to reach better performance and to lower the production cost.

Although new technology CMOS chips are available from multiple sources, most designers cannot afford to use them, and still meet the cost limits dictated by the overall budget for materials. See (*) in Table "1" for low standby current memory chips.

Naturally, lower guaranteed standby current CMOS devices are more expensive than those where the maximum standby current is given in range of tens of microamperes. (The value of typical standby current cannot be considered for battery life calculations). In addition, the larger the memory, the more critical the overall cost problem is.

Table "1" is showing comparison between several types of 2K x 8 memories (100-200 μsec access time range):

Manufacturer	Part No.	Typ. Stby. μA	Max. Stby. μA
Fujitsu	MB 8417-12L	-	30
Fujitsu	MB 8418-20L(*)	-	1
Fujitsu	MB 8418-15L	-	10
Harris	HM 6516	-	25
Hitachi	HM 6116LP	0.5	50
Integ. Dev. Tech.	IDT 6116L	-	20
Mostek	MK 48D02	1	10
Nec	MPD 446-3	0.01	10
OKI	MSM 5128-12(*)	1	3
RCA	CDM 6116A	-	25
Toshiba	TC 5117APL(*)	0.01	1

To serve those low standby current type memory chips, a small 160 mAh button cell may be designed in for two years of operation, but the overall standby must be guaranteed to be under 10 μA. If the total current becomes higher, a parallel configuration of small button cells or larger cells must be implemented.

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On the other hand, if originally, low cost higher standby current chips are considered, high energy density 1/2AA (850 mAh) or 1/6 DEL(1500 mAh) battery may serve the non-volatile memory bank for the life of the equipment.

The other advantages of the hermetically sealed $LiSOCl_2$ cells are:

* Higher cell voltage
* Lower self-discharge rates at elevated temperatures
* Wide operating temperature
* All Tadiran product line is U.L. recognized

The proper cost comparison between the various solutions is to consider the cost of one high energy battery serving a bank of low cost (relatively high standby current) memory chips versus a small low capacity button cell serving ultra low standby current (probably more expensive) memory chips, or in comparison to using non-volatile memory technology.

An additional reason for considering a larger back-up battery is to support an on-board Real Time Clock chip during the power down condition. Typically, most types require 10-20 μA back-up current, but the actual current may go higher than the typical value given by the chip manufacturer. In those designs, the additional capacity available from the high energy battery will make the battery a lifetime component.

Table 2 is showing capacity comparison between two Tadrian $LiSOCl_2$ cells and one carbon monofluoride (LiCfx) cell.

Type / Subject	Typical Coin Cell BR 2325	Tadiran TL-5101	Tadiran TL-5135
Voltage	3.0V	3.6V	3.6V
Size	Ø - 1.0" h - 0.1"	Ø - 0.56" L - 0.99"	Ø - 1.3" h - 0.40"
Capacity	170 mAh	850 mAh	1500 mAh

Table 2.

The following summarizes this application note, and describes the advantages gained by utilizing high energy battery in memory back-up application.

High Energy Battery + Low Cost Memory Chips + Real Time Clock (optional)	⟷	Low Capacity Coin Cell + Ultra Low Standby Current Memory Chips

NOTE: Please refer to our P-44 Lithium Catalog for additional battery sizes that are available.

TADIRAN™ LITHIUM INORGANIC BATTERIES

TECHNICAL NOTICE

LTN 12036

Subject: Implementation of Lithium Inorganic Batteries for RTC Applications

Since Real-Time Clocks (RTC's) such as National Semiconductor's MM58167A, MM58274, and MM5817A are designed to provide microcomputers with actual time data in seconds, months and years, a highly reliable back-up source of energy is of vital importance in case of main voltage failure or during a power-off state.

Based on CMOS technology, these RTC chips consume very low current from the voltage source. For example, National Semiconductor's Real Time Clock Chip normally operates from a 5V ± 5% supply, but standby mode consumes only 20 microamperes. Since battery back-up operation down to 2.2V allows continuation of time keeping when main power is off, these RTC's are excellently served by Tadiran™ Lithium Inorganic Batteries, an outstanding power source for low current applications because of their long shelf-life, high operating voltage and energy density.

The Tadiran™ TL-5134 is especially suitable for RTC applications, since it is a low height PCB soldered or plug-in component with 1000 mAh capacity and 3.6 cell voltage. In addition, the TL-5134's electrical performance and mechanical construction have been optimized for long operating time and convenient handling where density packaging is required. With its high capacity, the battery will not shorten the overall lifetime of the equipment. Indeed, the TL-5134 offers 100,000 hours or more than 10 years of continuous operation.

Due to its operating capabilities and the fact that the TL-5134 does not require a charging circuit, this component performs better than any battery of its size in memory back-up applications or as a long-life back-up voltage source for low power CMOS logic circuits.

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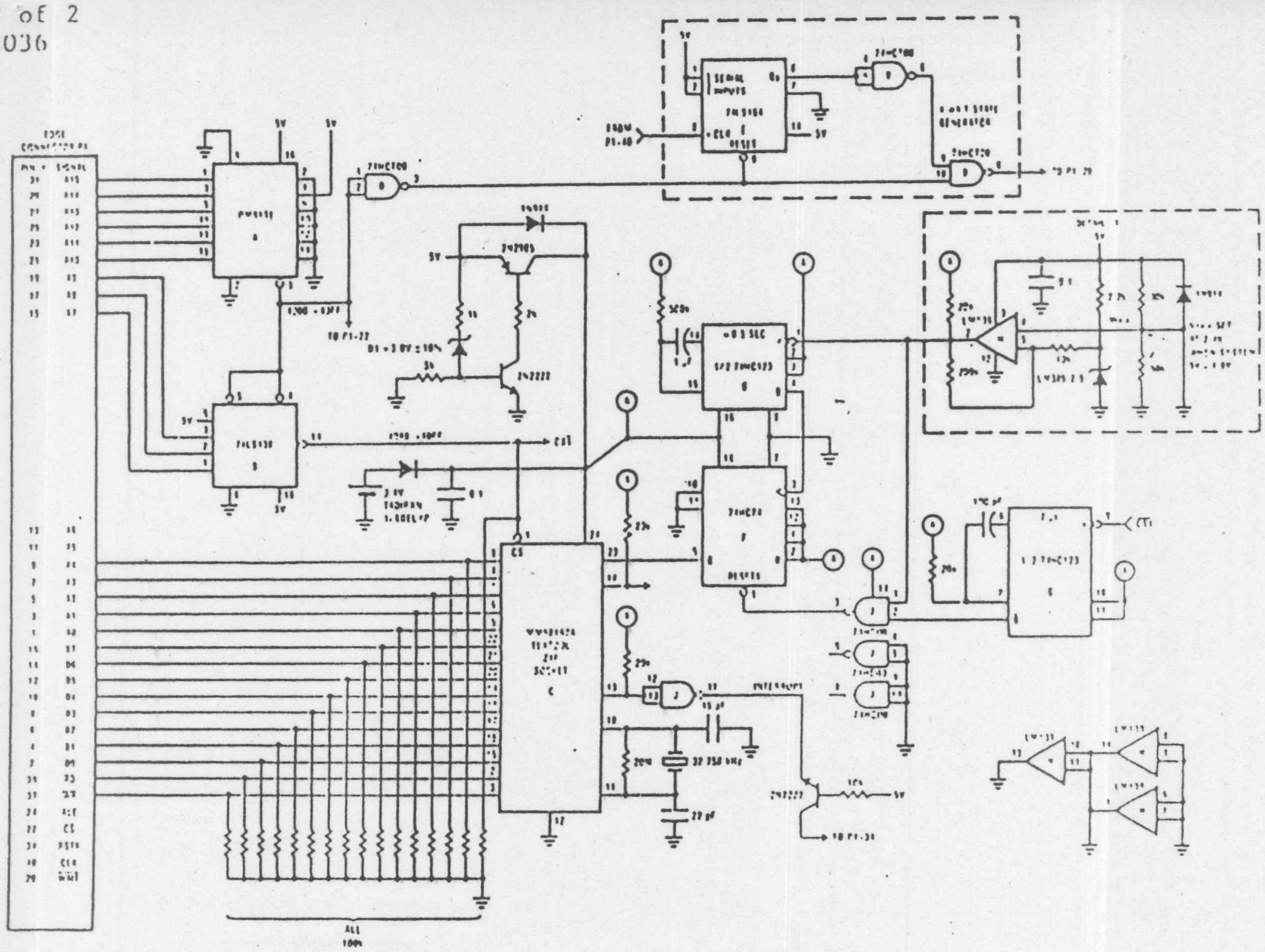

Detailed Schematic of Power Down Circuitry, and Interface to NSC888 Board

Figure 2 shows a typical configuration using an MM5816A in a microprocessor system. In this circuit the alarm and power up sequence is used as well as sleep and wake up states.

In case of main power shut down, a power-down (PD) signal is generated and this low level disconnects all I/O circuitry of the MM5816A except for stand-by interrupt and timing circuitry. This results in low power stand-by operation, which allows continuation of time keeping when main power is off. If the back-up battery is required to supply back-up voltage to more CMOS components, such as RAM's or logic IC's, a high capacity lithium inorganic battery, Tadiran™ TL-5134, may be implemented since its 1000 mAh capacity will provide enough energy to supply a large CMOS board for a long operating time. The back-up voltage will not fall below 3.0V even if a general purpose silicon diode (1N 4148) is used. The 0.1 microfarad capacitor will assure smooth switching between the main and back-up voltage sources.

To ensure low stand-by current during the power down condition, all RTC chip input lines must be equipped with 100K ohm pull down resistors.

References

AN 353 MM58167A Real Time Clock Design Guide
AN 359 MM58174 RTC in a Battery Back-up
AN 365 MM58274 RTC for Micro Processor System

TADIRAN™ LITHIUM INORGANIC BATTERIES

TECHNICAL NOTICE

LTN 12037

SUBJECT: RECOMMENDATIONS FOR CORRECT USE OF $LiSOCl_2$ BATTERIES

The TADRIAN Lithium Thionyl Chloride Cell is a long life memory back-up voltage source. Millions of batteries have been produced during the last 10 years of production, and a lot of experience has been collected from the field where the cells are used in a wide variety of applications.

As a direct result of this activity, various safety tests done by TADIRAN and reproduced by the U.L. Laboratories. The TADIRAN product line was recognized under the list of components (refer to TADIRAN Technical Manual, LBR-1507 and UL MH12193).

U.L. came out with recommendations of how to avoid extreme operating condition of the battery while installed in the equipment. The recommendations apply for situations when the components around the battery fail or they're installed improperly. Momentary shorting of the cell during soldering or other handling is not harmful, and has no affect on the capacity of the cell.

1. As an additional safety feature, short current limiting (in the case of the serial diode failure) should be provided by connecting additional 10K resistor in series with the diode, or using an additional serial diode. See Figure 1a, 1b.

   Note: Since the diode leakage current which is in the range of up to a few tenths of microampere doesn't cause any damage to the battery, a simple silicon diode (1N4148, 1N914, 1N4002, etc.) is recommended.

2. A good practice is using a pair of jumperable pins on the component side of the board, by which the Lithium Battery mounted already on the board remains totally disconnected until the assembled P.C.B. testing is completed, or during shipping in a conductive material. See Figure 1c.

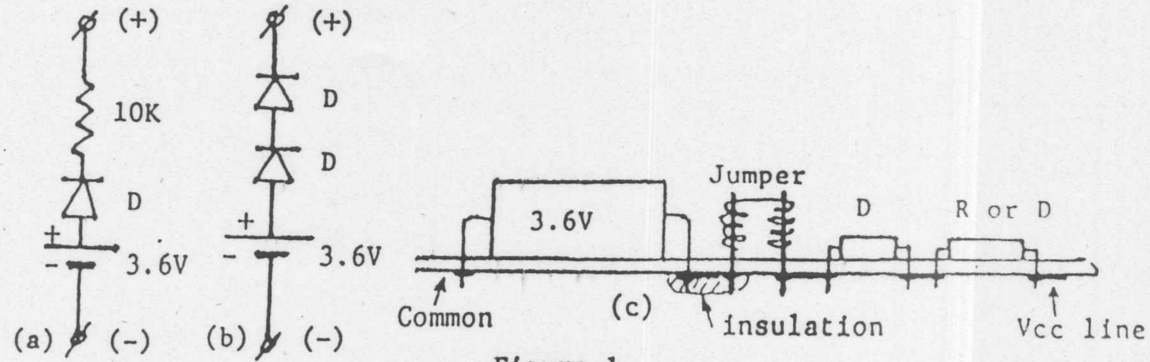

Figure 1.

3. For testing purposes, the open circuit voltage of the TADIRAN Lithium Thionyl cell (before the jumper installation) should be 3.66V minimum measured by a 10 MOHM input impedance digital voltmeter.

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TADIRAN LITHIUM INORGANIC BATTERIES

LITHIUM BATTERIES UTILIZED AS MAIN POWER SOURCES IN INSTRUMENTATION & INDUSTRIAL APPLICATION

LTN 06058

By: Dan Ehrenreich - Product Manager - Components
Tadiran, Woodland Hills (CA)

Lithium Thionyl Chloride batteries ($LiSOCl_2$) perform very well in low current applications like battery backup for Real Time Clock and CMOS memories. The major advantages of the $LiSOCl_2$ technology are: high operating temperature. It's inherent safety is achieved by utilizing the single layer lithium technology which results in moderate internal resistance in range up to 50 OHM.

Thanks to the recent improvement and expansion of the low power CMOS technology in microprocessor levels, there are many new types of instruments designed, in which this battery functions as a main power source. Among those applications are: remote reading utility meters, laboratory and medical pumps, security systems, optocoupled power switches, etc.

Usually in these devices, in addition to the low standby current, some occasional or periodical pulse current are drawn from the battery. For proper design with the battery, the phenomenon of initial passivation on the lithium layer should be considered. From the point of view of the design engineer, this passivation may be explained as a temporary increase of the equivalent internal resistance that causes reduction of the current capability.

To overcome this problem, or at least to limit it's impact, a parallel bleeding resistor may be permanently connected to the battery. (Figure 1). Continuous leakage current through the cell at the level of 0.02% of the expected peak current * will control the thickness and the resistance of the passivation layer and limit the voltage drop on the battery during the pulse to 3.0V minimum. The standby current through the CMOS circuitry may be considered part of the current through the cell, and the additional leakage current required through the bleeding resistor 'R' may be lower.

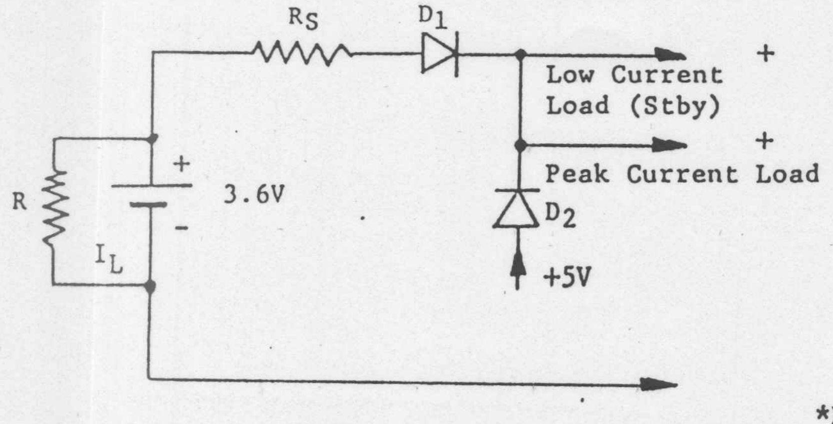


Figure 1.

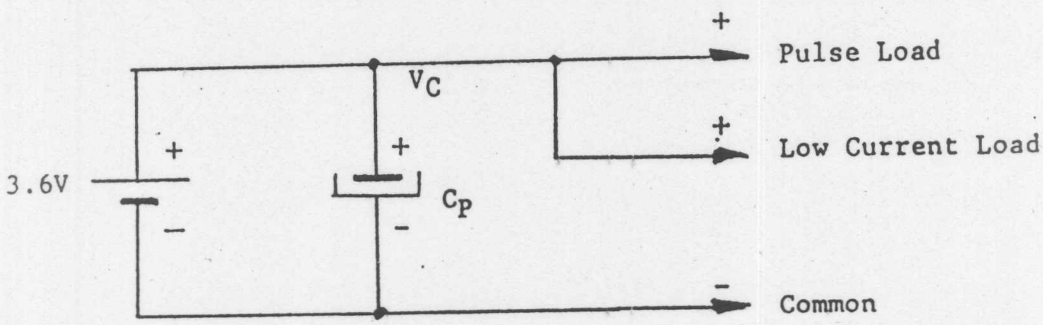
$$I_L = I\ peak\ /5000 - I_{STBY}$$

$$R = \frac{3.6V}{I_L}$$

*Refer to Table 1 showing maximum peak current, available from each type of battery.

In battery backup applications, D_1, D_2 are used for diode switching between power sources while R_S is a current limiting resistor required by U.L. (Underwriters Laboratories).

In most designs where a high peak current is drawn for a very short period, the principle of parallel capacitor may be considered. During the pulse, most of the current and energy is delivered from the charged capacitor connected in parallel to the battery (See Figure 2).



Special attention should be paid to the quality of the chosen capacitor. Naturally, no degradation in battery life should occur due to excessive leakage current through the parallel capacitor. The required capacity may be calculated by using the following formula (See Figure 3).

$$C_P = \frac{I_P \, \Delta t}{\Delta V}$$

I_P - Peak Current

ΔV - Max. Voltage drop during the pulse

Δt - Pulse width

T - Charging time of the capacitor between the pulses should be considered.

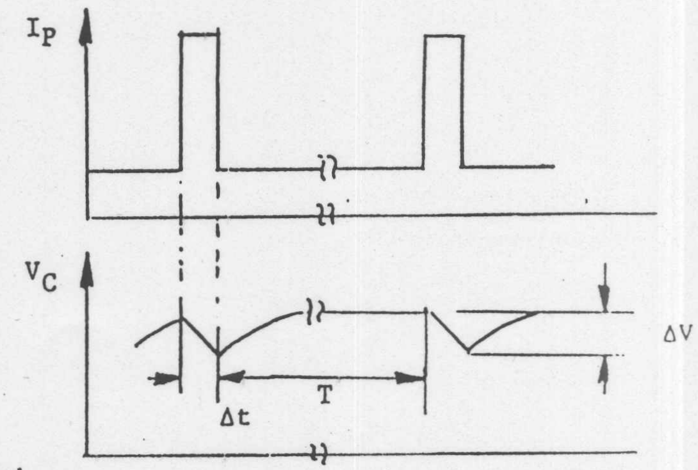


Figure 3.

There are applications where deep voltage drop on the pulse load may not necessarily be critical. On the other hand, the voltage on the battery-powered microprocessor circuit must remain uninterrupted. The low current drawn by the µP circuits is in range of 10 - 100 µA, while the infrequent short pulses may be in range of 10 - 100 mA. Figure 4 shows a typical circuit around the backup battery, and the interconnection to the main power supply +5V. The serial resistor should have the minimum value as required by U.L. In some applications, an additional diode may be used in lieu of the resistor (refer to U.L. recognition MH 12193 for more details).

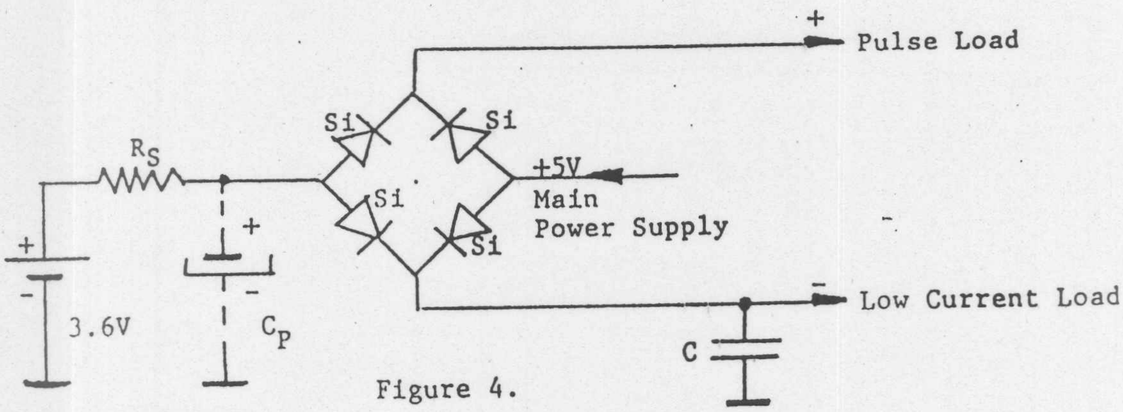


Figure 4.

Both power sources are connected to the load through diodes. Those diodes will avoid charging of the battery from the +5V and eliminate discharging of the capacitor through the pulse load.

In portable or remote instruments, the +5V power source doesn't exist. Figure 5 shows the circuit where the battery is the main power source.

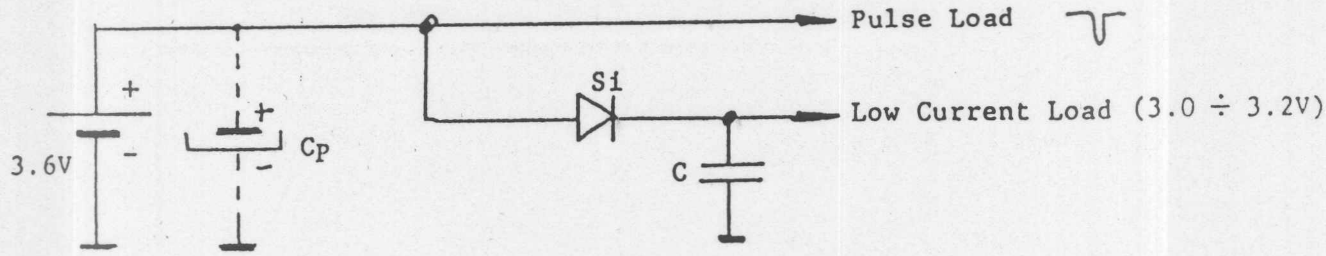


Figure 5.

In both designs,(Figure 4, 5) the capacitor "C" will deliver the low current to the circuit during the pulse. This output voltage should remain in range of 3.0 ÷ 3.2V, while the battery voltage may drop during the pulse below the 3.0V level. An additional electrolytic capacitor C_p may be connected in parallel to the cell as shown in Figure 3.

The calculation of the capacitor's value should take into consideration the actual pulse width and the particular load current drawn from each capacitor during the pulse. The timing diagram and the formula as shown in Figure 3 may be utilized in both cases.

End of the battery life may be sensed by measuring the voltage on the battery during the pulse. Since low battery voltage may cause improper operation of the circuit, indication for battery replacement should be incorporated. Figure 6 shows a simplified circuit which includes the battery voltage sensing circuit and the "assisting capacitor" C as well. For more accurate voltage detection, a low power operational amplifier like the LM339 may be implemented.

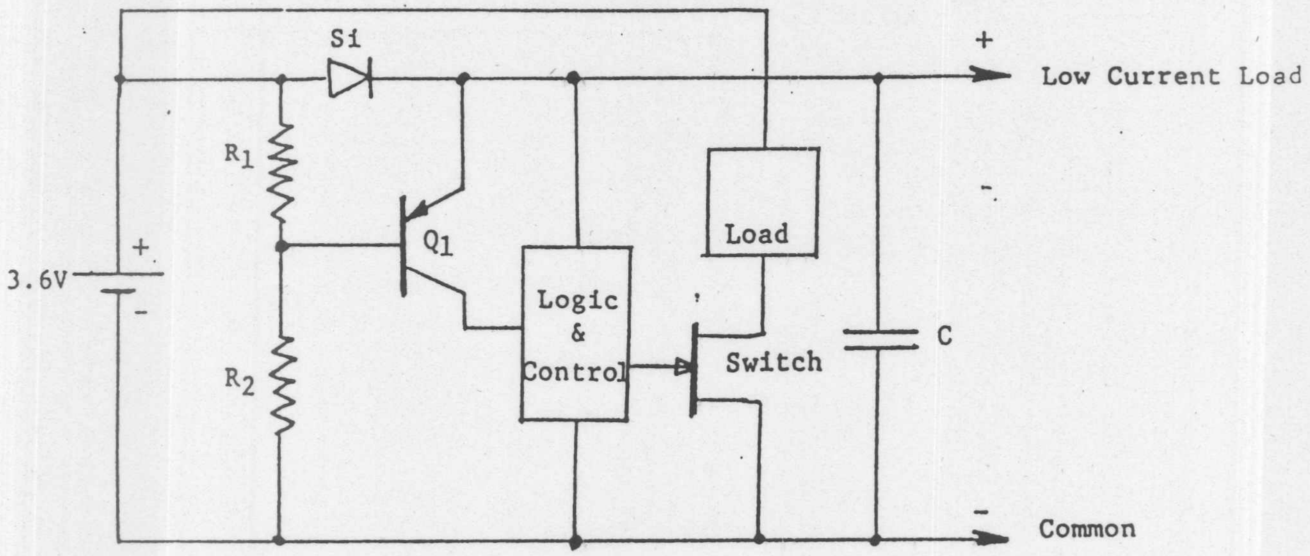


Figure 6.

The relative value of the resistors R_1, R_2 should be calculated in such a way that transistor Q_1 will begin to conduct current if the battery voltage drops below a certain predetermined level. The output signal from the collector of the LM339 output is fed into the logic circuit.

Table 1 shows the maximum recommended pulse currents drawn from each of the different $LiSOCl_2$ cell sizes. The listed data is related to an operating temperature range of +20°C ÷ 70°C. Obviously, below the 20°C level, there is a gradual degradation of the maximum current due to increase of internal impendance, and the output voltage may decrease accordingly.

Battery Type	Nominal Capacity	Max. Cont. Current
TL-2150 1/2AA	0.8 Ah	15 mA
TL-2100 AA	2 Ah	42 mA
TL-2200 C	5 Ah	90 mA
TL-2300 D	10 Ah	150 mA
TL-5137 DD	30 Ah	300 mA

Table 1.

Thanks to many unique characteristics of the Lithium Thionyl Chloride Technology and availability of low power components, these batteries will serve the equipment in most cases for it's entire life.

By utilizing one of the above detailed design ideas, the engineer will find the Tadiran Lithium Technology attractive, cost effective, and easy to design with. Implementation of this high performance power source will upgrade the marketing advantages, and add some real technical improvements to the battery-powered equipment.

LTN 06059C

TADIRAN

LITHIUM BATTERIES

SERVE THE P.C. INDUSTRY

Implementation of $LiSOCl_2$ Technology in Business Computers as a backup battery to the Motorola MC146818 Real Time Clock

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Prepared by

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Real Time Clocks (RTC) are designed to provide computers with actual data in seconds, minutes and up to years. Uninterrupted Real Time tracking has become necessary features in today's high performance Personal Computers used for businesses. Today, thanks to the availability of low power CMOS technology, RTC's consume a very low current while powered from the Battery Backup Voltage (BBV). Two operating modes are detailed below:

ACTIVE MODE : The Real Time Clock is ready to communicate with other devices on the bus, and is powered from the +5V main power supply.

STANDBY MODE : This is the low power operating mode. The Vdd is supplied to the RTC from the on-board backup battery and draws a very low current in range of tens µA. The clock continues to run, but the bus is not active.

The Real Time Clock is switched to the standby mode as a result of an input signal from the power supply voltage detection circuit. This assynchronous input is created by a transistor circuit or a comparator. Fig. 1.

The battery begins to supply the current after the main voltage decreases below 3.2V. In STANDBY mode, the operating life of the battery may be calculated based on one of the following assumptions.

Home Computer : The battery capacity is calculated for 100% backup time, because the computer is "OFF" most of the time.

Off. Computer : The battery provides the backup current during nights, weekends, etc. Calculation is based on 75% backup time.

Ind. Computer : The computer is powered most of the time. The calculation is based on 35% backup time. (i.e., holidays, weekends).

Figure 1 shows the typical circuits recommended for the MC146818 and its upgraded version, the MC146818A.

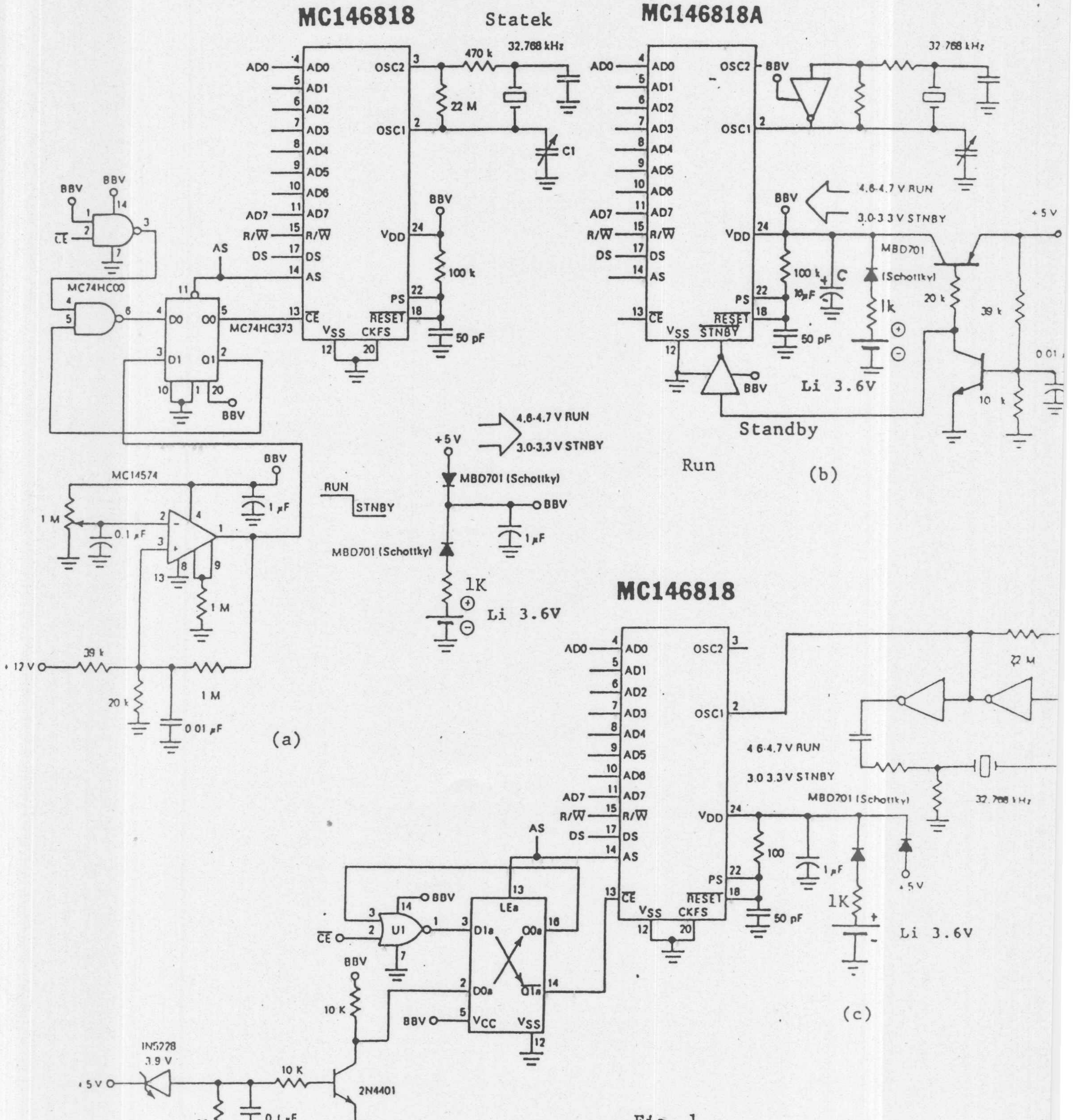


Fig. 1

According to the Advanced Data Sheet published by Motorola, both versions, the MC146818 and MC146818A, are specified to operate in STBY mode on minimum BBV of 3.0V. However, according to Technical Notice AN894, the MC146818 requires an external synchronization and latching circuit for the $\overline{CE}$ and AS inputs. In Fig. 1a, this function is created with the MC74HC373 (or HC75) and the MC74HC00 components. To avoid problems during the transition to STBY mode, an alternative solution for the MC146818 may be arranged by limiting the voltage drop on the Vdd during this transition to 4V. In Fig. 1b the capacitor C (10 µF) will hold the voltage on the Vdd pin after +5V decrease, and limit it to 4V during 0.2 seconds (calculation based on 50 µA). As a result of this solution, the original MC146818 may operate on the minimum standby voltage (3.0V) without the need for the external logic.

To generate the $\overline{CE}$ signal (Fig. 1a) or the $\overline{STBY}$ signal (Fig. 1b), any of the above circuits may be used, but the proper timing should be considered. Fig. 2c While selecting the value of the capacitor C(on BBV)Fig.2a should be considered. The minimum voltage of the backup battery should be 0.4V above the 3.0V level due to voltage drop on the serial diode, and the current limiting resistor.

The serial current limiting resistor R (1K) is required by Underwriters Laboratories (U.L.) as an additional safety device to protect the battery in case of shorting on the board or improper installation of the battery. In low current application like backup source for RTC's, the resistor value should be in range of KOHM's.

To design the circuit for the lowest standby current, the 3.6V battery technology will provide the best solution. Batteries are available as a single cell or in customer replaceable packages including an internal resistor and connector. Convenient mounting means as a Velcro pad may be utilized.

The backup currents drawn by the Motorola RTC MC146818 and MC146818A in standby mode are shown in Table 1. Those current levels were measured in a test circuit operating at 32 kHz frequency with the specified crystal (CX1V) connected to the RTC circuit as shown in Fig. 1a. The circuit shows a Pierce type clock oscillator which utilizes the internal NAND gate.

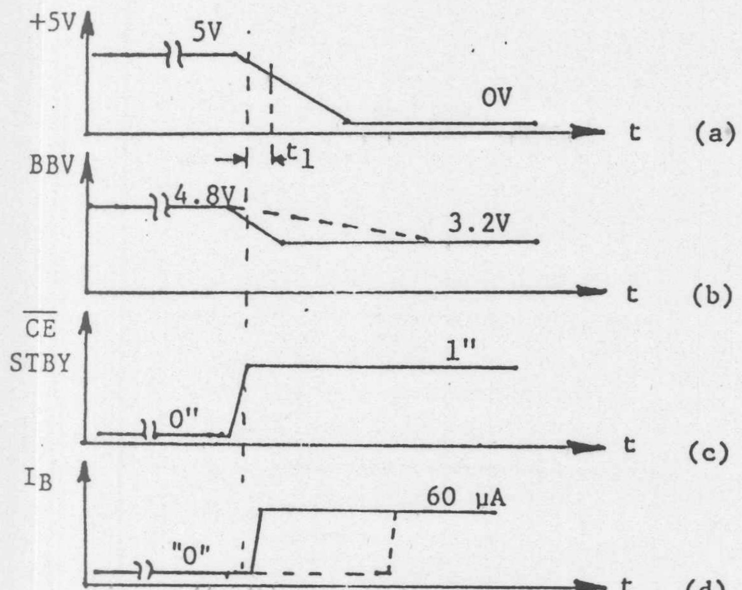


Fig. 2.

* Power Supply Turn "OFF". Voltage falls below 3.2V within t_1

* Voltage drop on the BBV may be delayed by the capacitor "C"

* Timing signal for STANDBY OR $\overline{CE}$ inputs.

* Battery starts to supply current to the RTC

Volt / Data		3.0V	4.0V	5.0V
STBY	Typ.	60 μA	100 μA	200 μA
	Max.	80 μA	140 μA	300 μA

Table 1.

The overall standby current from the battery may be reduced by implementing an external 32 kHz clock circuit. Due to lower current capability, of the external CMOS gate, the circuit (Figure 1b & c) will draw a lower operating current at 32 kHz frequency than the built-in inverter in the MC146818, or the MC146818A, and will operate on 3.0V as well.

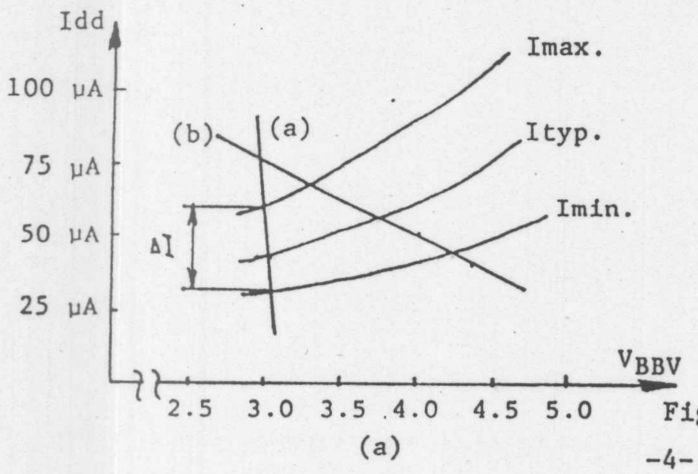
The typical value of the standby current at the 3.0V level is 20 μA, and the external clock powered from the BBV line (see Fig. 1b&c) requires also about 20 μA operating current. Table 2 shows the combined current consumption of both circuits.

Volt / Data		3.0V	4.0V	5.0V
STBY	Typ.	40 μA	50 μA	80 μA
	Max.	60 μA	100 μA	160 μA

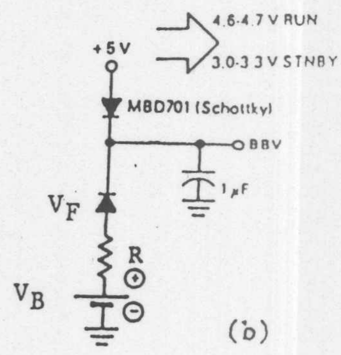
Table 2.

Figure 3a shows the curves that characterize the current drawn by the RTC Fig. 1c Motorola MC146818 in standby mode. The straight lines (a) (b) crossing the curves, determine the actual BBV voltage on the RTC for the particular current level. Line (a) is related to the 3.6V battery configuration preferred due to the lowest possible standby current and constant voltage throughout the battery life. Line (b) is related to higher voltage batteries with a large serial resistor. Fig. 3b shows the basic circuit and the formula for the serial resistor value calculation.

$$R_{MAX} = \frac{V_{Bmin} - V_F - V_{RTC}(min) - V_R}{Idd\ max \quad Vdd(min)}$$



(a)



(b)

Fig. 3

When selecting the size of the battery, one should take into consideration the typical standby current and the type of application as described above. The following formula may be used:

$$C = \frac{I(typ).\,Y.P.\,8700^*}{1000}$$

C - Capacity (mAh)
I - Typ. Stby. Current (μA)
Y - Years of operation
P - Fraction of backup time %/100

*Consider 8700 hours/year

Example

For a P.C. used in a typical home application, the battery life may be calculated as follows (Vdd = 3.0V, Refer to Fig.1):

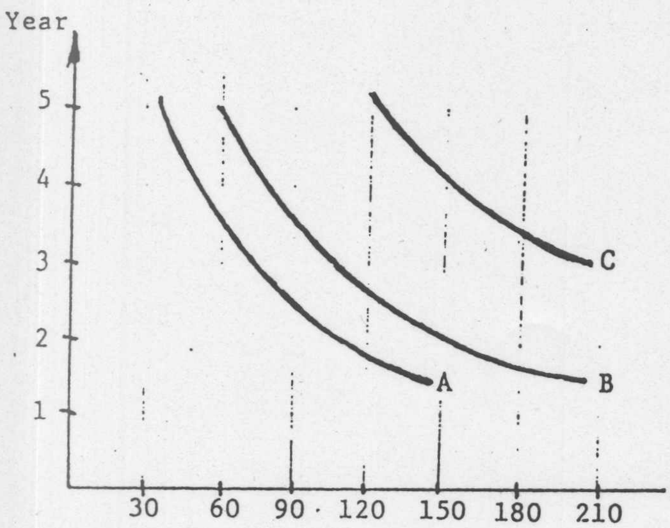
Y = 4 years
P = 90%
I = 50 μA

$$C = \frac{50.4.8700.0.9}{1000}$$

C = 1570 mAh

To compensate for tolerances of capacity, self discharge rate (1%/yr. aver.), possible higher standby current, etc., a battery with more capacity is recommended. The AA size $LiSOCl_2$ cell has capacity over 1.8 Ah (50 μA), and 3.6V constant operating voltage for the entire battery life. In applications where a 2-year battery life is required, the ½AA size, with capacity of 850 mAh, may be used.

For maintenance instructions, to determine the time between battery replacement, Figure 4 shows the operating time of the AA size battery utilized in different standby battery applications.



Operating Modes

C - 35% Batt. backup time (industrial)

B - 75% backup time (office application)

A - 100% backup time (home application)

Battery Type

TL-5104 - 1.8Ah typ.(50 ÷ 100 μA)

Fig. 4

The backup current in the specific application, may be measured in the standby mode or the data found in Tables 1&2.

Figure 5 shows the typical discharge curve of the TL-5104 AA size Lithium Thionyl Chloride cell. As previously mentioned, it's flat discharge curve, excellent capacity retention and moderate internal impendance are among the unique advantages of this technology.

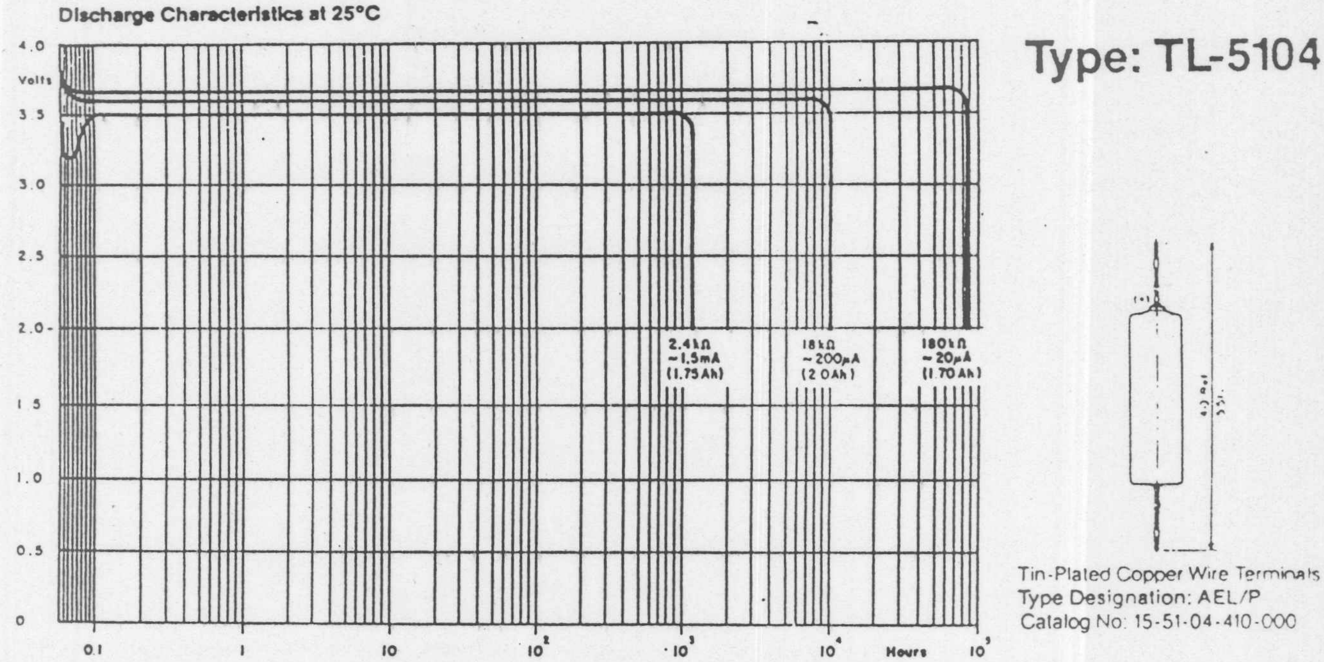


Fig. 5.

Due to these superior operating capabilities of the $LiSOCl_2$ type cells, as manufactured by Tadiran, and the fact that they do not require a charging circuit, this technology performs well as a backup battery to Real Time Clocks and CMOS memories. It's high energy density and convenient mounting make this Power Source a long life component perfectly suited for computer applications

Thanks to the excellent low power characteristics of the MC146818 Real Time Clock, the Personal Computers are provided with Real Time reference through many years of uninterrupted operation.

References:

1. MC146818A advance information ADI-1026-MOTOROLA
2. User considerations for MC146818 AN894-MOTOROLA
3. MC146818 Addendum ADI 856R2-A1-MOTOROLA
4. Comparison of oscillator designs TN-24-STATEK
5. TADIRAN Lithium Inorganic Batteries - P.L. - TADIRAN

TECHNICAL NOTICE

LTN 07064-B

Subject: Lithium Batteries for Modem Applications

Since the modems have become very popular in the computer network, there are many new features available to enhance it's performance.

In addition to it's basic function, the "digital voice communication," today's modem has the ability to answer on the phone line, automatically re-dial busy numbers, or even store frequently used numbers in the internal memory. The telephone numbers are pre-programmed into the onboard R/W memory.

Some simple modem types are powered from the phone line while the sophisticated ones require more power, are fed from the power line, (110V). Uninterrupted data storage and convenience reprogramming are among the important features of the upgraded performance modems used for business communication. Thanks to the availability of the low power CMOS technology while operating on the backup battery voltage during power failure or power off, the internal memory consume a very low current. The standby current is in range of 5-20 μA.

The battery will supply the low current to hold the data in the memory after the voltage of the main power drops below 3.3V. Diode D_1 will get blocked and D_2 forward biased.

The terminal voltage of the Lithium battery is 3.6V, and the actual standby voltage will be 3.0V minimum. See Figure 1.

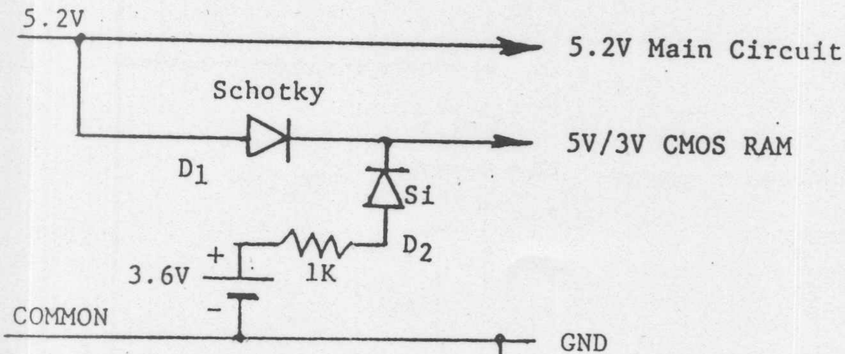


Fig. 1

$$C = \frac{I_{typ.} \cdot Y \cdot 8700}{1000}$$

C - Capacity (mAh)

Y - Years of operation

I - Standby current

*8700 hours/year

When selecting the size of the battery, one should take into consideration the typical standby current drawn by the CMOS RAM. The required capacity is calculated by the formula detailed above. Lithium Thionyl Chloride batteries are available in capacity range of 0.3 Ah-2.0 Ah, in form of low height wafer cells or cylindrical types. Most types are ready for soldering on the PCB or plugged into the battery holder.

For more detailed information, refer to detailed catalog available from our Regional Offices and local Representatives.

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